BOARDWALK ENGINEERING GUIDE

INTRODUCTION

This publication has been developed specifically to raise understanding and knowledge of professional engineers designing timber boardwalks. Much of the information presented here is applicable only to Gatton Sawmilling Company systems. This publication is one of two *(Boardwalk Design Guide and Boardwalk Engineering Guide)* produced for Gatton Sawmilling Company by James Pierce & Associates, Consulting Engineers. The Guide is intended to be read in conjunction with the Boardwalk Design Guide

While care has been taken to ensure coverage of the design principles for boardwalks, the versatility and adaptability of this form of construction is only but touched on here and so the information must be regarded as incomplete. The information shown on the drawings herein does not constitute a complete design so a Consulting Engineer with skills in both timber design and foundation systems should be engaged for the structural and foundation design. Additionally, interpretation of the foundation material should be entrusted to a Geotechnical Engineer as many boardwalk locations have extremely poor soils.

DESIGN STANDARDS

Deck System

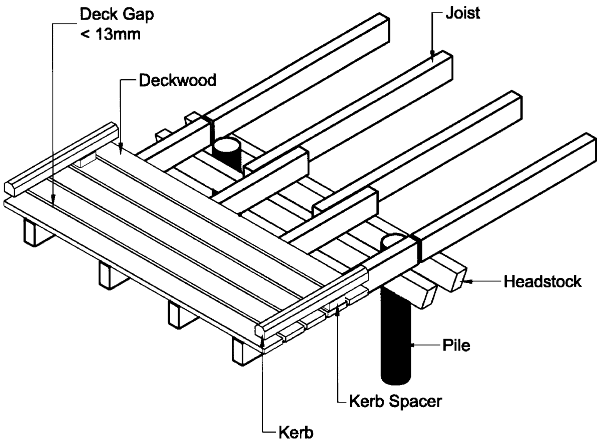


Fig 2 Normal Deck System

The normal deck system shown in Fig 2 facilitates change of direction at each pile/post bent. Internal joists can overlap to provide continuity of deck fixing while edge joists need to butt up so that the external appearance is uniform and to ease handrail installation. The double headstock distributes the load into the pile so that, in many situations, a single bolt is all that is required. Headstocks project beyond piles to ensure development of full bolt strength as well as a fixing for the handrail post, if required. Decking gaps depend on the users and Deckwood shrinkage. Guidance on shrinkage and gaps is given in the Deckwood Technical Data Sheet.

LOADS

While timber members for private decks may be sized adequately by using domestic framing manuals, this publication is intended for boardwalks completely weather exposed and with public access. For longevity and performance, the loadings on public precincts are much heavier than domestic loadings. The client or approving authority may require it to comply with the requirements for building *(BCA)* or bridging (AustRoads or NAASRA). The former is likely if it constitutes an extension to a building while the latter would claim authority if it was within a road reserve. When the boardwalk's location is in a park the jurisdiction is unclear. The BCA implies less loading unless there is a crowd panic situation and that scenario *(5 kPa)* is improbable unless a boardwalk has handrails on both sides to contain a crowd. The BCA allows more variety in handrailing depending on the consequences of falling.

As would be expected, the bridge codes demand a higher design load and apply uniform railing requirements as falling from a typical bridge would always be imagined as life threatening. The AustRoads Bridge Design Code (1992) is in a Limits State Design *(LSD)* format but makes no reference to timber. The NAASRA Bridge Design Specification (1976) uses a permissible or Working Stress Design *(WSD)* method and refers directly to the old Timber Code AS1720 - 1975. This required application of an exposure factor (N) to account for some strength and stiffness loss in-service. Recent testing of existing road bridges has confirmed that this does occur. A 15% reduction in both bending strength and stiffness has been applied in the tabulations in this Guide.

Boardwalks do not usually form part of an essential transport link and so temporary closure for maintenance or damage repair is not as disruptive as it may be for conventional pedestrian or cycle bridges providing access to work or school.

TABLE 1
LIVE LOADS ON DECK

Source Document & Sections	Uniformly Distributed Load	Concentrated Live Load
AS 1170.1		
Sect 3.6 Footpaths, terraces & plazas leading from ground level - restricted to pedestrian traffic	4.0 kPa	4.5 kN
Sect 3.4 - wheeled trolleys	5.0 kPa	4.5 kN
Sect 1.1 - general housing & NAFI Timber Framed Housing Design - Methodology & Performance Criteria		1.8 kN on 350 mm^2 with a serviceability limit of 1.7 mm for a 1 kN point load on a single board
NAASRA 1976 Bridge Design Spec. *(Permissible stress)*		
Decking & joists	5.0 kPa	
Headstocks & foundations	4.0 kPa	
AUSTROADS 1992 Bridge Design Spec. *(Limits States)*		
Loaded element supporting up to 85m^2	5.0 kPa	

Maintenance/Construction Loads

The 4.5 kN concentrated load is equivalent to an infrequent, slow-moving vehicle with a maximum gross mass of 1.5 tonnes. This allows for limited construction and maintenance traffic distributed into four pneumatic tyres each spreading the load over 150 mm x 150 mm area.

Golf Cars & Equivalent

A deck designed for the 4.5 kN load above also allows for the continuous use of low speed golf cars with a gross vehicle weight of 8 kN *(500 kg kerb weight plus two occupants)* with 2.5 kN wheel loads concentrated over 100 mm x 100 mm. Skewing the deck planks by 7° to the direction of travel and the use of 120 mm minimum width decking should be used to reduce rattles and improve ride. This is facilitated by skewing the abutments.

Tractors & Other Equipment

Golf course and park maintenance equipment vary greatly in mass. Provided that they are no heavier than golf cars their passage is allowed; otherwise specific design is required *(and the requirements may change with changing equipment). [AustRoads specify a 20 kN concentrated wheel load for tractors crossing pedestrian bridges. This would increase the decking cost considerably and is outside the scope of this report].*

Physical barriers and load limits may need to be posted on vehicle accessible boardwalks to restrict traffic. Note that other infrequent traffic may have to be catered for *e.g. ambulance, fire and refuse trucks. Guidance is not given for these in this report.*

Animal Loads

Widely spaced boards resemble stock grids and are not compatible with livestock. As well, livestock *(horses included)* loadings can be considerable and would unduly govern decking design and should be excluded from these structures. Prohibition notices should be posted for the benefit of horse riders in areas where this use is a possibility.

Design Loads

Typically Uniformly Distributed Dead Loads for the boardwalk superstructure range from 1.25 to 0.85 kPa depending on deck thickness, width, kerb and railing arrangements.

The Concentrated Live Load of 4.5 kN governs the relative movement between decking planks.

In the tabulations that follow, 5 kPa has been used as the conservative design Live Load for decking and joists. The headstock and piling have been designed on a UDL Live Load of 4 kPa based on deck area assuming that the peak *(5 kPa)* loading is not distributed uniformly over the complete span *(this may not be valid with lookouts)*.

The Serviceability Uniformly Distributed Loads usually govern joist design even with a generous deflection under full load. A stiffer deck is necessary for golf cars to improve ride and reduce rattle as these decks do not have the benefit of running planks or a deck wearing surface as do conventional timber vehicular bridges.

Decking Design

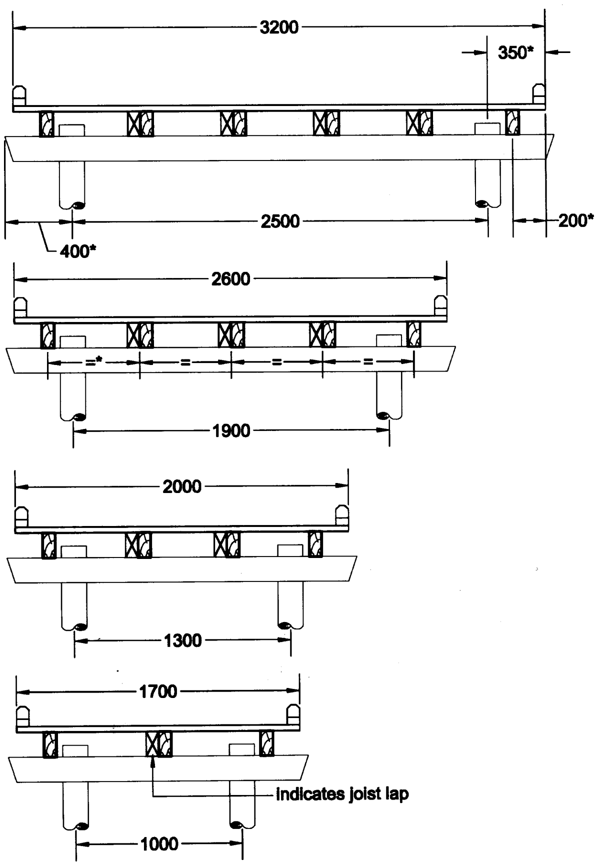


Fig 3 Typical Framing Layout for Pedestrian & Cycle Boardwalks

* Indicates typical dimensions

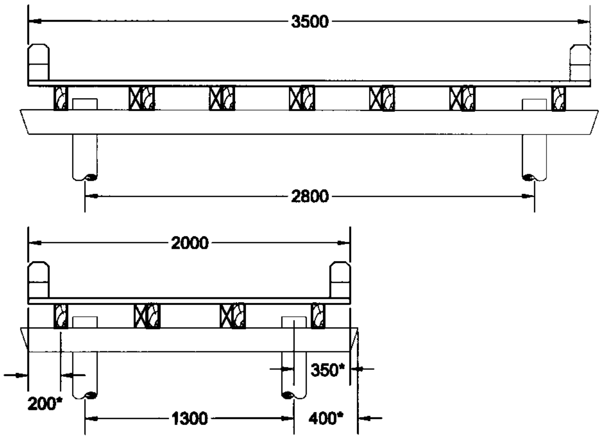


Fig 4 Typical Framing Layout for Golf Car Boardwalks

* indicates typical dimensions

Concentrated Loads on Decking

Point Load

The intensive concentrated castor load of 1.8 kN over 350 mm^2 produces a compression perpendicular to grain of 5.1 MPa *(5.2 MPa is permissible)*. This means that less dense timbers *(S3 to S7)* would not meet this criterion. *i.e. Douglas fir and Slash pine would be overloaded 100%, hem-fir, meranti, and hoop pine would be even worse; most likely suffering visible damage.*

Concentrated Load

An equivalent concentrated load per plank in Table 2 has been derived from distributing 4.5 kN over a 150 mm square.

TABLE 2
CONCENTRATED 4.5 kN LOAD DISTRIBUTED INTO DECKING

Deckwood width mm	Effective conc load/plank kN
70	2.5
95	3.2
120	4.0
145	4.5

For frequent wheeled loads Deckwood needs to be at least 120 mm wide to produce a smoother ride and to reduce decking rattle.

For a wheel load applied at the cantilever edge of the decking assume that there is a kerb at least 75 mm wide; so the load is effectively concentrated 150 mm from the nominal edge *i.e. neglect the situation of a vehicle mounting the kerb as this is a crash situation; not a design situation.*

TABLE 3
DECK DESIGN CASES (2 SPAN CONTINUOUS ONE SPAN LOADED ONLY)

Live Load Case	Load	Serviceability limit
Uniformly distributed	5 kPa	span/360
Concentrated	4.5 kN (refer table 2)	span/180
Concentrated (pedestrian & cycle)	1 kN	1.7 mm
Concentrated (golf car)	2.5 kN	1.7 mm

The uniformly distributed load is easily carried. The spans are limited by serviceability under concentrated loads including the relative deflection between adjacent deck planks.

TABLE 4
MAXIMUM CONTINUOUS DECKING SPAN

Deckwood size	Pedestrians & Cycleways		Golf cars
	Normal Profile	Reeded Profile	Normal Profile
35x70	500	460	N/A
35x95	650	580	N/A
35x120	660	590	590
35x145	660	600	630
45x70	830	690	N/A
45x95	960	890	N/A
45x120	980	900	770
45x145	990	910	820

Decking Fixings

Hardwood used in Deckwood is very dense and so it belongs to the strongest joint group. As the price of grade 304 stainless steel decking screws is very reasonable there is very little cost increase in a project in specifying these screws and the finished product is so superior. 14# gauge batten screws are used for fixing decking and are Timber Teks (formerly type 17 screws). While these are nominally self drilling, the holes should be predrilled and countersunk or the screws may be overstressed by overdriving and break off. The screw head needs to finish flush with the deck and this is the reason that countersinks need to be pre-drilled. Fixing details are given in the construction instructions.

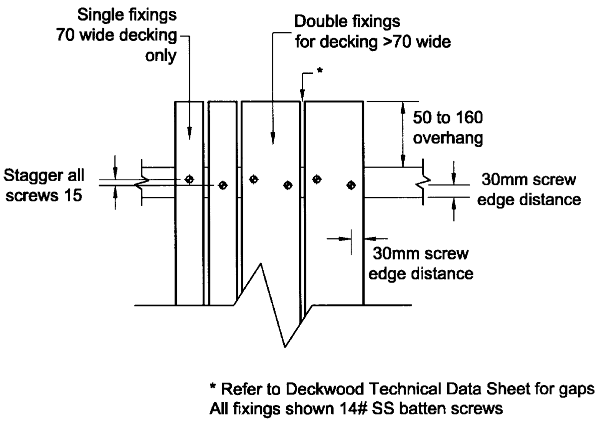


Fig 5 Deck Screw Spacings

Deck fixings need to be placed some distance from the ends to reduce end splitting that may be initiated by the decking screws restraining cross grain shrinkage. For this reason, decking should cantilever past the outside joist.

Joist Design

The timber used for joists and headstocks is drawn from superior hardwood, the properties of which have been verified by In-Grade testing and is designated Joistwood. The species and surface defects are limited so that they perform satisfactorily as exposed structures. Member design is mostly governed by serviceability requirements so there is a huge reserve of strength.

TABLE 5

BENDING STRENGTH & STIFFNESS FOR JOISTWOOD (MPA)

	WSD	LSD
Bending strength f'b	32	78
Short term mod of elasticity E	14400	14400

TABLE 6

JOIST & HEADSTOCK DESIGN CASES (SIMPLE SPANS)

Live Load Case	Load	Serviceability limit
Uniformly Distributed *(foot & cycle)*	5 kPa	span/180
Uniformly Distributed *(golf car)*	5 kPa	span/360

TABLE 7

MAXIMUM JOISTS SPANS FOR ARRANGEMENTS CONFORMING TO FIGS 3 & 4

	Joistwood Size	
Application	150x75	200x75
Pedestrian & Cycle	3.6 m	4.9 m
Golf Cars	2.9 m	3.9 m

These joist spans are maxima. The nominated pile spacings should be significantly less as they have to take into account out-of-position driving tolerances as well as the skewness of the headstock introduced by changing the direction of the walk. On mangrove walks and similar, pile positional tolerances may be up to 0.5m different from the theoretical due to avoiding tree roots and poor underfoot conditions providing a less than ideal platform for the pile driver. If a pile location has to be adjusted, a general rule should be to reduce the longitudinal spacing.

75 mm wide joists are recommended to allow staggering of decking screws as this reduces the tendency to propagate cracks in the joists and facilitates connection to the headstock.

Headstock Design

Vertical load transfer to the post/pile dictates the headstock system. Load transfer can be accomplished by a bolt only or a timber bearing seat *(supplemented by a bolt fixing)*. Bearing seats are often cut poorly resulting in uneven bearing and are sometimes trimmed to the wrong level or orientation. The cutting of the timber post can expose less durable timber in softwood piles while disposal of waste is sometimes of concern to supervisors. Gatton Sawmilling Company has adopted the bolted system whereever possible as it is more reliable and almost foolproof but its capacity is limited. For practical deck sizes, a double headstock is needed to reduce bolt loads to acceptable limits.

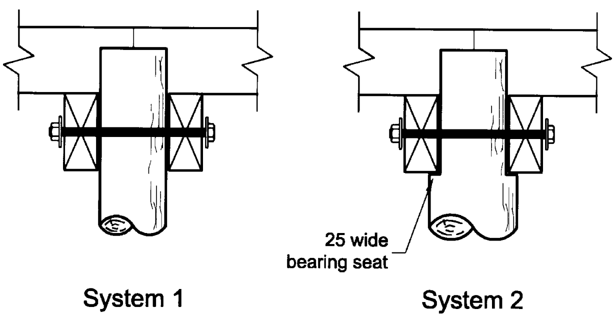


Fig 6

Table 8

HEADSTOCK JOINT SYSTEM SHORT TERM (5 HOUR) CAPACITY AS PER FIG 6

Bearing Seat	WSD	LSD
no	17.7 kN	24 kN
yes	40 kN	56 kN

TABLE 9
HEADSTOCK APPLICATION

System	Bolt dia.	Bearing seat	Limitation for 3m pile spacings
1	M20	no	2/150x75 Joistwood headstocks Deck widths to 2m Normal & Golf Car loads Piling 150 J3 min joint group
2A	M20	yes	2/150x75 Joistwood headstocks Deck widths to 2.6m Normal & Golf Car loads Piling 200 J3 min joint group
2B	M20	yes	2/200x75 Joistwood headstocks Deck widths to 3.5m Normal loads Deck widths to 3.2m Golf Car loads Piling 200 J3 min joint group

A single M20 bolt is the practical maximum and bolt edge spacing limitations require a minimum headstock depth of 150 mm. Bolt fixings for joists dictate that headstocks be 75 mm wide. So, for most applications, double 150x75 headstocks have been adopted.

The galvanized M20 bolt, together with an epoxy coating, provides a robust connection that has high corrosion resistance. For uniformity, and to facilitate some handrail systems, it is appropriate to use posts/ piles turned to uniform diameters. For low height walkways, 150 mm uniform diameter posts are most suitable enabling uniform bolt lengths to be ordered. These are only available as treated plantation softwood poles.

With increasing deck width, the strength/stiffness of the headstock becomes critical. Therefore, a larger size, together with a stronger connection and higher capacity pile, may be required. It is often appropriate to drive another pile to obviate this but the additional post/pile can be difficult to align as discussed elsewhere in this document.

In situations where additional span lengths *(beyond 3m)* or widths *(beyond 1.8 m)* increase the connection load, load bearing seats have to be adopted. In those cases, larger diameter piles are called for *(to increase the skin friction because of the increased load being carried),* so it is appropriate to adopt bearing seats that maintain 150 mm between the headstocks so that handrails and bolt lengths remain the same for consistency and to reduce inventory.

Handrail Loading

In low risk situations, a draped rope or steel cable may suffice to define the extent of the deck; restricting pedestrians to the boardwalk. Where proper handrails are installed, they have to resist both lateral and vertical loadings.

Rails and stanchions need to resist simultaneous loads, horizontal and vertical, of 0.75 kN/m *(AUSTROADS 1992 Bridge Design Spec., NAASRA 1976 Bridge Design Spec. & AS 1170.1).* AustRoads requires a stiffness such that the rails do not deflect more than span/800 and stanchions:- post height/500. This requirement is unrealistic for timber. A limit of span/ 400 for handrailing has been adopted as more suitable for this material. Additionally AS 1170.1 requires 3 kN/ m lateral load to restrain crowds *e.g. platforms for crowds watching performances, panic situations etc.*

TABLE 10
MAXIMUM HANDRAIL SPAN

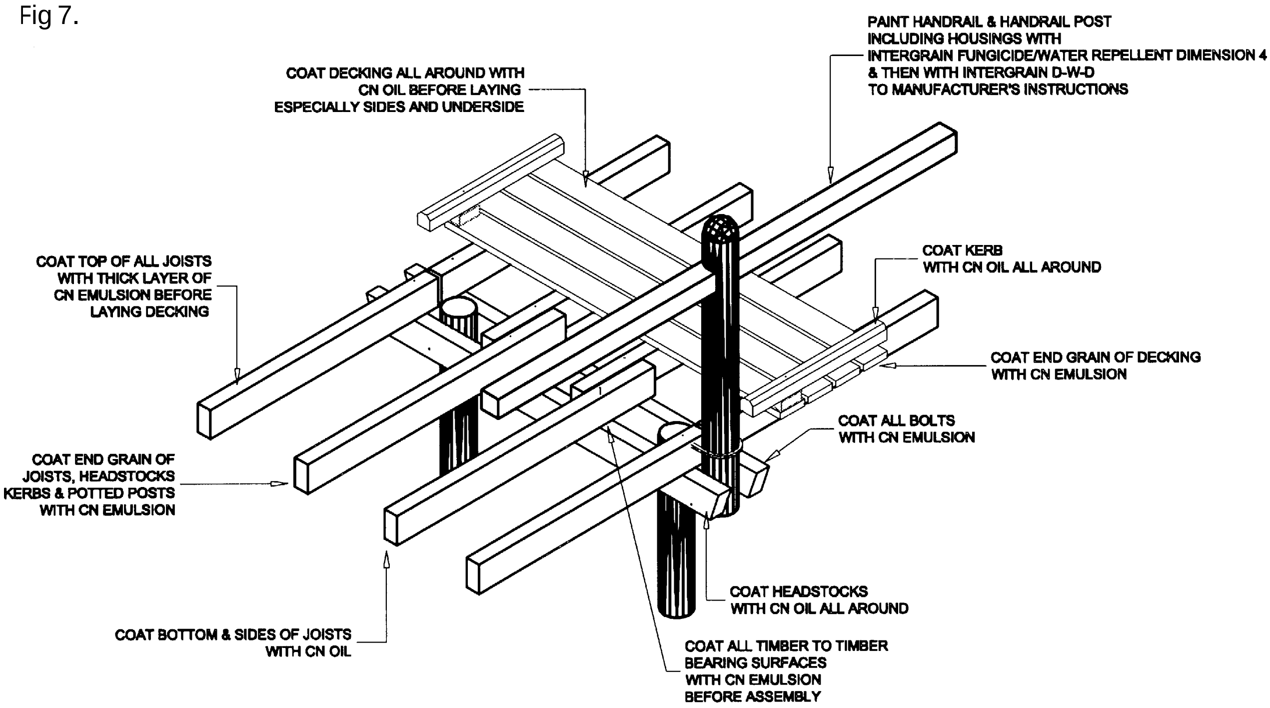
Deckwood (handrail)	Max Span (span/400)
75x75	2.2 m
100x100	3.6m

Practical handrail sizes *(100x100)* restrict post spacing to 3.5m or so and this is also the limit of 150 mm deep Joistwood. Where the larger joists are used, support for the handrails from intermediate supports are required.

Kerbs

It is recommended that kerbs resist vertical and lateral loads of 0.75 kN/m. 75x75 Deckwood kerbs, 3.5 metres long, meet this criteria when continuous over a central support block *(3 supports).* For golf cars a larger kerb is recommended to serve as a vehicle barrier. A 125x125 Deckwood kerb spaced above the deck should give satisfactory performance. Where additional protection is required railings can be installed.

Fig 7.



Protection

Timber Finishes

Preservative treatments such as Copper Azole and CCA are very effective in stopping degradation due to sapwood decay and insect attack. Consideration will still need to be given to minimise degrade due to the effect of high UV, stress from wetting and drying, trapped moisture in the timber to timber interfaces and moisture intake at the end grain. Figure .... illustrates our recommendations to address these potential problem areas.

A boardwalk which is treated in this manner can expect to reach its maximum service life.

Substructure

Foundations

Foundations for boardwalks are often very poor soils with high watertables but there is also a large variability in foundation conditions for long boardwalks. Design Pier Loads of 35 kN *(LSD)* are typical for decks 2 m wide and supported every 3 m by a pair of posts *(assuming a reduced average Live Load of 4 kPa)*.

TABLE 11

PIER TYPE SUMMARY

Ground Conditions	Soft Ground	Watertable	Stiff Ground	Rock
Pier Type	Piled or Bedlog		Potted	Drilled anchorage

Marine Mud

Often boardwalks are located in marine mud. Discounting the support offered by vegetation's surface roots, if the bare ground cannot support a person's weight, the safe bearing capacity is less than 20 kPa. Unfortunately, this is about half the intensity of the so-called Low Bearing Pressure crawler machines and so equipment often has to work from timber mats to distribute loads over an even larger area.

Fig 8. Driving Piles in mangroves

In mud, the only practical solution is to drive piles. Timber piles are most effective as they facilitate connection and trimming and do not rust. While piles may carry the load down to a stronger layer buried under the mud, most sites have alluvium so deep that friction piles have to be used. Then, virtually the whole load from the structure is transferred to the ground by the friction between the timber pile and the ground. For this to be effective, the embedded surface area of the pile has to be significant.

Advantages of timber over steel piles:

- larger friction *(surface)* area for same unit cost means shorter pile
- easier to trim
- easier to make top connection
- easier splicing
- easier to handle
- larger lateral resistance

Small pile drivers are normally used as:

- smaller zone of disturbance to vegetation
- small load and light piles
- smaller mats required
- pile frame can fit under trees with minimal disturbance of tree canopy.
- less mass of piling plant means less risk and consequence of bogging.

Pile lengths typically range from 3 m to 8 m. A drawback of a small pile frame is that piles have to be spliced as the pile leaders may not allow piles more than 3.6 m long to be pitched. This has several disadvantages:

- splices have to be kept well under the surface so that lateral resistance is developed without resort to cross bracing
- steel splices may corrode if oxygen is not excluded
- tension capacity reduced significantly *(but this is only called on in extreme loadings)*

Control of pile location, verticality and driving may be less than what is called up in the Piling Code *(AS 2159)* due to the poor ground conditions and restrictions of the site. For these reasons it is best to have only two piles in a bent as three or more piles in a bent *(group)* introduce alignment problems when joining them with a continuous headstock. For similar reasons, it is best not to let driven piles protrude to form the handrail. Installing the handrail stanchions later allows control of verticality and some control over position.

Of course, within the tidal range, barge based pile driving is a possibility but barge size and draft usually limit this option. Manual driving of friction piles is not an option as monkey weights of more than 100 kilograms are required. In certain foundation conditions, jetting *(eroding the ground around the pile with water and air introduced by a steel lance attached to the pile)* may be used.

Soft Ground

When the surface bearing capacity is 50 kPa or better with the deck height closely following the ground as in freshwater swamps or similar, a bedlog system may be used. A large slabbed log is placed horizontally on a prepared base of gravel and the boardwalk installed on top. If any settlement occurs the system may be easily re-levelled by jacking and packing. Minimal excavation and equipment is needed so the presence of water is not a problem. Bedlogs and prefabricated decking may be moved on trolleys over the completed deck minimizing site work.

Fig 9. Gatton Sawmilling bedlog system

Stiff Ground

Ground that has a bearing capacity of 100 kPa or better and no significant watertable can be readily excavated to form a base using a potted post system. Excavation is neatly done with an auger mounted on a Bobcat or similar so access limitations are not usually a problem. Timber can be placed exactly in position and plumbed and secured during backfilling so these verticals may protrude to form the handrail system if required. Again, from an appearance and cost point of view, it is usual to design posts as freestanding *(cantilevering)* so that permanent diagonal bracing is not required. When the ground conditions are such that embedment *(necessary to develop full bending strength)* is not possible *(rock near the surface)*, other bracing systems have to be explored.

The presence of a watertable within the embedment zone can make the hole excavation unstable so driven piles may be resorted to. In that situation, preboring the ground may assist in improving the alignment of the driven posts.

Hardwood posts decay prematurely when concreted in excavated holes so compacted gravel backfill has to be used. This requires more labour and can be a problem maintaining posts in line while compacting the gravel. Hardwood posts are not available in small consistent diameters and they are not as convenient as pine posts. When potted poles are used, the preferred system is treated, parallel sided pine posts with concrete backfill.

Sand

Piles may also be installed in sand using jetting and this may reduce equipment size. Potted piles are not recommended unless the sand is very compact, dry and, at least, weakly cemented. A high watertable may cause a *quick* condition precluding excavation. While expensive dewatering options can counteract this, driven piling is the answer.

Sand has poor lateral capacity. Where this is a problem, buried deadmen can increase lateral resistance by distributing horizontal forces over a larger area. Sand is easily scoured by wave and flood. On coastal dunes, the fine grains are eroded by the wind. It is prudent to make some allowance for this loss of support to the lateral stability of the structure.

Rock

Sometimes these structures are built to traverse a rock slope. Foundations in rock are a problem, cost more and are more difficult to set out. While posts can be potted into some weak rocks *(600 mm minimum)*, rock is generally resistant to pier excavation. Then rock drills or coring machines are required to drill holes of 75 to 100 mm dia. about 400 mm deep to accept steel supports. Then lateral forces have to be resisted by other means for decks over one metre or so.

Fig 10 Rock baseplate in cored hole

Other means include:

- welded steel frames
- inclined posts
- bracing back to other stiff points
- X bracing
- moment base plates

Where rock floaters are encountered, or where weathering is variable, it is important that the rocks to be drilled are stable themselves and of sufficient size to provide support. Often smaller rocks may be moved by equipment, hydraulic jacks or explosives to allow a normal excavated pier.

Slope Stability

Usually most natural slopes are stable but once we steepen the slope with earthworks there may be some downhill movement due to the increased weight of the formation. The use of boardwalks reduces this problem as the mass of the system is very much less than the equivalent earthworks and should maintain the existing stability. Look for signs of recent instability including scours. Crevices, steep gullies, sloping vegetation are all danger signs. Avoid these areas, if you can, by picking a more stable route.

Wetland Boardwalks

These additional requirements are for boardwalks constructed over water.

Marine

In salt *(marine)* water, and even in brackish water *(20 kilometres from the mouth of most rivers)*, live borers that attack timber. Most of the attack is below high water and is worse closer to the equator.

Various options can be adopted for timber within that zone:-

- use naturally resistant species
- pressure treat *(usually double treated i.e. both water borne and oil borne preservatives are used together e.g. CCA + Creosote)*
- envelope completely, but still need durable timber
- adopt a non-timber solution *(and with all the problems that it entails)*

For exposed piles, the hazard level for preservative treatment is H6 and, even if an enveloping pipe is installed, piles must be treated to at least H5 level. In recent times H4 treatment has become the norm for *(non-critical)* landscape timber so one must check the end branding to see that timber has been treated to the correct level. There must be no holes or cuts to the treated material within the tidal zone and so the use of diagonal bracing to resist lateral load is limited.

Fresh Water

Foundation timbers for freshwater or in ground without any groundwater need to be Durability 1 or 2 with any sapwood treated H5.

Durability 2 timber in the substructure is permitted in most boardwalks as the difficulty in replacing it is not great. Where the superstructure is significant or the deck very large, consideration may be given to exclude Durability 2 foundation timber.

Deck Alignment

Deck Level

A low deck is more economical and less obtrusive but the final level is normally controlled by extreme water levels especially in wetlands and creeks.

Factors to be considered in deciding on a deck level:-

- HW *(high water)* mark *(for protection against marine borers)*
- HAT *(highest astronomical tide)* is the largest tide for the year
- Storm surge *(additive to at least HW but it is possible for this to occur during the highest tide HAT)*.
- Wave action *(additive to above as is worst during storms and cyclones)* and this depends on the fetch *(length of water over which the wind acts)*
- Shelter from wave action *(e.g. mangroves)*
- Consequences of overtopping *(damage to structure)*
- Greenhouse effect *(increase in water level in the future)* depending on the life of the facility.
- Flood level for structures further up rivers where tidal effects are less controlling.

Other factors to be considered include:

- wind action, but this is generally of no consequence unless railings are substantial or buildings *e.g. birdhides* are constructed on top.
- erosion due to tidal or flood action removing lateral support to piles/foundations.
- disaster prevention from an abnormal combination of weather circumstances *e.g. tying the structure together so that damaged sections may be supported by intact ones so that parts do not become a navigation hazard.*
- light craft loadings where it is possible that small boats may tie up to the structure during maintenance or operations.

Data on water levels may be available from the Local Council. The usual water levels are evident from the existing surface *(giving some thought to the current season and recent rainfall)* as well as the nature of the vegetation and underfoot conditions. Recent flood levels may be indicated from debris left in trees and shrubs or from talking to adjacent landowners.

Usually, if there is a natural or artificial water level control structure *(e.g. weir)*, the water level can be maintained in a close range so that the deck can be located just above the water *(typically 500 mm)*. Usually the controlling scenario is flooding but, in many situations, the boardwalk is located in a shallow backwater where the stream velocity is low.

Grades & Curves

Alignment *(including grades, vertical clearances and horizontal alignment)* is more stringent for the disabled and cyclists. *(It is discussed in some detail in the Design Guide.)*

Lateral Loads

Lateral forces are generated from:

- wave action
- wind
- walking
- vehicle braking
- seismic
- floodwater including debris
- moored craft

These loads are significant to the substructure design.

Debris can come from floodwaters or from wave action associated with storms or cyclones. Debris that has to be removed by hand includes grass, plastic and sea grass. More substantial water borne rubbish such as trees and branches may have to be sawn into more manageable portions for removal. While design procedures for log impact and such are established for bridges *(AustRoads)*, lightweight boardwalks are usually not robust enough to take the loadings without considerable extra expenditure. Usually any damage caused is confined to a small section while the temporary loss of the facility *(during repair)* is acceptable and so designing for log impact is not recommended.

In a marine location, any break to the treated pile envelope to provide diagonal bracing can be a source of deterioration, especially where it presents a lodgement point for marine borers. For this reason, bolted cross bracing is not used. Instead, lateral capacity is best achieved by the inherent bending stiffness of the timber pole cantilevering out of the ground. This is the main reason splices must be kept well underground. Failing this, piles can be raked *(inclined to the vertical)* so that lateral loads can be taken axially rather than bending. Sometimes other bracing systems have to be resorted to achieve a stiff deck.

A 1.5 kN load at deck level should be applied to each post as a very minimum.

Fabricated Steel

In general, use of metal brackets is restricted as the situations *(exposure, treated timber and often salt spray)* are very corrosive. While a low profile deck can be achieved using steel joist hangers, they are not recommended for the same reason. Where a stamped metal bracket such as a triple grip or joist hanger must be used it should be stainless steel with stainless fastenings. All other metalwork is galvanized and an additional paint system is used where it is in contact with timber and the ground.

Conclusion

Gatton Sawmilling prides itself in its expertise in rugged external public structures including shelters, walls, bridges, barriers and boardwalks. It is committed to innovation while retaining what is best of traditional practice in outdoor timber structures.

Boardwalks are an important part of the range of products and can be adapted and customized to the client's requirements. Detailing of decking layup, junctions and handrailing can all be modified to suit a client's theme, such is the versatility of this style of construction.

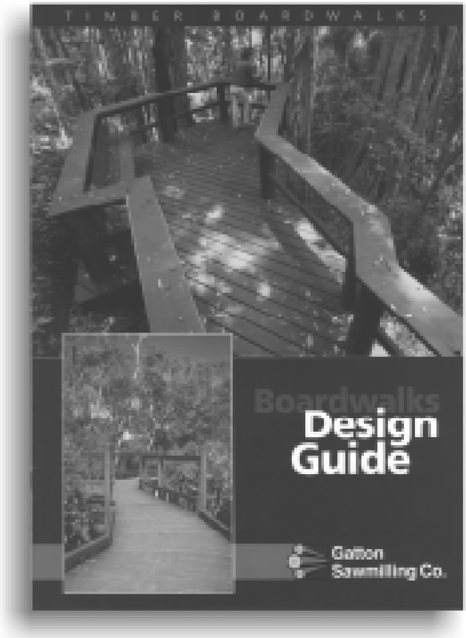
REFERENCES

AS refers to an Australian Standard as numbered.

BCArefers to the Building Code of Australia.

NOTICE:

This publication is a stand alone document, however a preceeding 20 page publication called "Boardwalks - Design Guide" completes this set.



If you require a copy of this document or a copy of Gatton Sawmills product brochures such as:

- Deckwood;
- Timber Boardwalks;
- Timber Foot Bridges;
- Traffic Control Products;
- Park Furniture; and
- Timber Treatments.

please contact:-

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